Global Change and Air Pollution

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Background

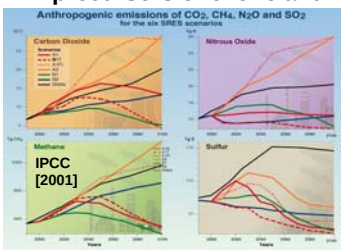
Question:

How will global change affect our goals for clean air?

We are facing rapid global change including changes in

1. Anthropogenic emissions

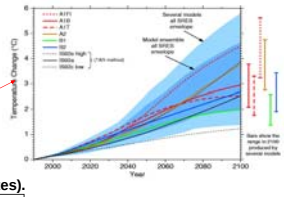
including greenhouse gases and precursors of ozone and PM



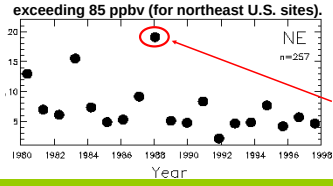
While significant decrease of U.S. anthropogenic emissions is projected by 2050, global total emissions are expected to increase.

2. Climate

Rapid climate change driven by increasing green house gases.



Number of summer days with 8-hr ozone exceeding 85 ppbv (for northeast U.S. sites).



Weather is a key variable affecting air quality.

Anomalously hot & stagnant summer of 1988 led to highest ozone year on record [Lin et al., 2001].

Methodology

We are addressing the above question through the EPA STAR Global Change and Air Pollution (GCAP) project. We first use a state-of-science global model, GEOS-Chem, to study the trends of air quality during the period of 2000-2050, with a focus on ozone and particulate matter. The GEOS-Chem model has a fully coupled treatment of ozone-NO_x-VOC chemistry and aerosols (http://www.as.harvard.edu/chemistry/trop/geos/).

The GEOS-Chem model is driven by the GISS General Circulation model (GCM) through the interface specially developed for this project [Wu et al., 2006]. The GISS GCM has been widely used for studies on global climate change. The future trends of greenhouse gases and anthropogenic emissions are taken from the IPCC [2001] assessment with updates.

We are also nesting the EPA /CMAQ regional model in the GEOS-Chem global model, using the boundary conditions provided by GEOS-Chem for better analysis of regional pollution episodes in future climates.

Collaborators

Argonne National Laboratory
CalTech
EPA ORD/NERL/AMD/MEARB
Harvard University
NASA/GISS
University of Tennessee

Ongoing and future work

- Continue interpretation - why does the effect of climate change reverse when U.S. anthropogenic emissions decrease?
- Analyze simulation results for aerosols.
- Carry out additional years of simulation for a more statistically robust assessment.
- Continue assessment of the effects of transboundary pollution influences on U.S. air quality in the future.
- Conduct copupled GEOS-Chem/CMAQ simulations to better capture regional trends in air quality.
- Investigate additional climate change scenarios.

References

Intergovernmental Panel on Climate Change, *Climate Change: The Scientific Basis.*, Cambridge University Press, Cambridge, United Kingdom, 2001.

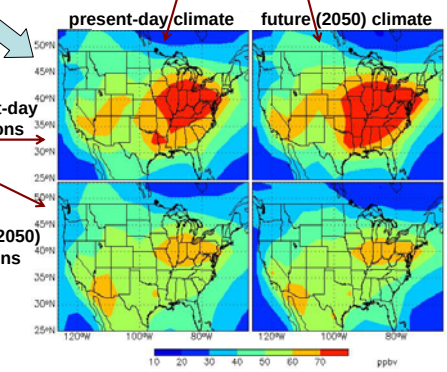
Lin, C.-Y. C., D.J. Jacob, and A.M. Fiore, Trends in exceedances of the ozone air quality standard in the continental United States, 1980-1998, *Atmos. Environ.*, 35, 3217-3228, 2001.

Wu, S., et al., Why are there large differences between models in global budgets of tropospheric ozone? submitted to J. Geophys. Res., 2006.

Preliminary Results*

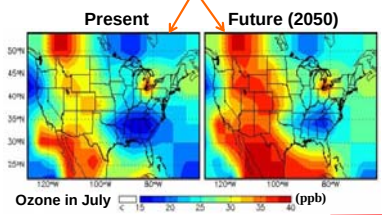
Average Jun-Aug afternoon levels of surface ozone simulated under different scenarios.

The future climate is projected to cause ozone increases compared to present-day if emissons remain constant.

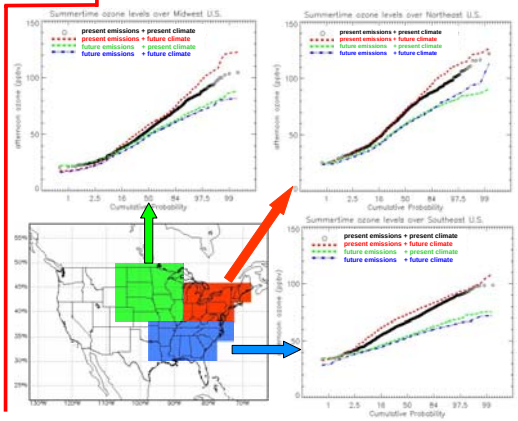


However, if anthropogenic emissions in U.S. decrease as projected, the effect of climate change would be in general to further decrease ozone!

But background surface ozone (assuming no anthropogenic emissions in U.S.) is expected to increase due to rising methane and transboundary pollution.



The U.S. is projected to experience higher ozone extremes (stronger pollution episodes) in the future climate unless anthropogenic emissions decrease.



Conclusions

- Climate change is likely to result in poorer air quality if U.S. anthropogenic emissions remain constant.
- Reductions projected for U.S. anthropogenic emissions may have compounded benefits by mitigating and possibly reversing the effects of climate change on air quality.

* The results presented here for different scenarios (present versus future emissions and present versus future climate) are from a1-year model simulation. The trends in anthropogenic emissions are taken from A1 scenario of IPCC [2001] with updates.

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